File ACT/047/002

SEEP RIDGE SHALE OIL CO.

GILBERT SHALE OIL CO. – OPERATOR
A KIEWIT COMPANY

5258 Pinemont Drive
Suite B-280
Murray, Utah 84123
(801) 262-0108

March 29, 1985

Mr. Ronald W. Daniels, Acting Administrator
Minerals Resource Development and
Reclamation Program
Division of Oil Gas & Mining
355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, UT 84180-1203

RE: Annual Report MR-3, Seep Ridge Project,
Act/047/002 Uintah County, Utah.

Dear Ron:

Enclosed please find the 1984 Annual Operations and Progress Report (MR-3) for the Seep Ridge Project.

During 1984, no new revegetation activities took place. Land disturbance consisted of construction of light access roads to hydrologic monitoring sites as shown in Figure 1.

The total acreage within the disturbance boundary shown in Figure 1, and by area on the soil tabulation chart of MR-3, is approximately 83 acres. This total, however, does not agree with the total acreage affected to date, 66 acres, by individual years (Page 2, MR-3). The discrepancy in these acreages is because the area affected in the mining sequence (83 ac) includes acreage that has not been disturbed.

A preliminary status report of the U.S. Forest Service revegetation test plot has been attached to the MR-3. This report presents general observations of the plot recorded during sampling in 1984. Sampling of the study plot will continue during 1985.

If you require any additional information or have questions regarding this submittal, please feel free to contact either Bill Sharrer or me at (801) 262-0108.

Sincerely,

SEEP RIDGE SHALE OIL CO.

Catherine V. Chachas

Catherine V. Chachas
Environmental Affairs Manager

CVC/ks

MR Form 3
(Revised 1984)

RECEIVED
MAR 2 9 1985
DIVISION OF OIL
GAS & MINING

ANNUAL OPERATIONS AND PROGRESS REPORT

From Month/Year JAN 84
to Month/Year DEC 84

(To be submitted for each mining operation at the end of each calendar year to the Division at this address:)

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING
355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203
(801) 538-5340

OPERATOR: SEEP RIDGE SHALE OIL COMPANY MINE NAME: EXPERIMENTAL SITE #1

ADDRESS: 5258 PINEMONT DRIVE, SUITE B-280
MURRAY, UTAH 84123

PERMIT NUMBER AND DATE OF PERMIT: ACT/047/002 3/23/79

REPRESENTATIVE: CATHERINE V. CHACHAS

SECTION(S): 2 TOWNSHIP(S): 14S. RANGE(S): 22E

MINERAL(S) MINED: OIL SHALE

STATE AND/OR FEDERAL MINERAL LEASE NUMBERS: # ML 24276A

SPECIAL USE PERMITS AND/OR RIGHTS-OF-WAY: BLM RIGHT-OF-WAY U-45956 (See Figure 1)

Section 40-8-15 and Rule M-8 of the Utah Mined Land Reclamation Act, requires each operator to include with this report an up-dated map and plan prepared in accordance with Rule M-3, as outlined in the requirements for annual report maps in Appendix I, providing a detailed status of all mining and reclamation activities which have occurred during the past year.

The report should include:

MINING:

(a) Tabulation of acreage disturbed (by pits, roads, facilities, etc.) during the report period with illustration on a current map.

Disturbance	Acreage
Pit	N/A
Roads	1.2
Facilities	0
Waste Dumps	0
Other	8

(b) Tabulation of acreage affected to date (by years).

Date by Year	Acreage (Total
1975	2
1976	5
1977	10
1978	6
1979	15
1980	3.5
1981	7.0
1982	3.5
1983	13

(c) Tabulation of all topsoil (new) stockpile volumes (see chart below) and date of stockpiling.

SOIL TABULATION CHART

Area Affected (in mining sequence) (If more space is needed, please attach.)	Area 1	2	3	etc. Access Roads
Acreage of Area	15	54	12	2.0
Depth of Topsoil Removal (inches)	0	12	12	0
Depth of Topsoil Replacement (inches)*	0	6	0	0
Estimate of Topsoil Volume Salvaged (yd^3 or ac ft)	0	2.5	1.5	0
Volume Actually Salvaged (yd^3 or ac ft)	0	2.5	1.5	0
Volume Required for Reclamation (yd^3 or ac ft)	2.0	10.0	1.5	1.0
Surplus or Deficit Volume (yd^3 or ac ft)	(2.0)	(7.5)	0	(1.0)
Storage Status (short- or long-term)	N/A	L	L	N/A

Soil Tabulation Chart (continued)

Area Affected (in mining sequence)	Area 1	2	3	etc.
Storage Location	--	*	*	--
Area Where Soil Has Been Used (if not stored)	--	*	--	--
Running Total (all stockpiles) (yd^3 or ac ft)	--	2.5	0.5	--
Short-term	--	--	--	--
Long-term	--	2.5	0.5	--

*Of previously stripped area recently reclaimed.

(d) Tabulation of all (newly removed) out-of-pit spoil volumes, date of placement and illustration on a map.

Area	Date	Acreage
N/A		

(e) Tabulation of quantity of commodity mined.

	Commodity	Tonnage
(Mined)	IN-SITU OPERATION - NO ACTUAL MINING OCCURS	
(Milled)		

(f) Description of any new construction during the report period with illustration on a map, including, but not limited to:

1. Buildings and support facilities.
NONE

2. Roads.
ACCESS ROADS TO MONITORING SITES AND DEVELOPMENT AREAS WERE CONSTRUCTED DURING 1984. TOTAL AREA OF DISTURBANCE WAS APPROXIMATELY 1.2 ACRES (FIGURE 1)

3. Diversion ditches, collector ditches, interceptor ditches, etc.

NONE

4. Culverts.

NONE

5. Sediment ponds, containment ponds.

NONE

6. Monitoring sites (vegetative, air quality, surface subsidence, surface water or ground water, etc.).

EIGHT WATER MONITORING SITES (SIX GROUND WATER AND 2 SURFACE WATER) WERE CONSTRUCTED DURING 1984. EACH GW SITE CONSIST OF THREE WELLS AT DIFFERENT DEPTHS WHILE EACH SURFACE WATER SITE HAS FLOW AND SEDIMENT RECORDING OR COLLECTION DEVICES.

7. Topsoil stockpiles.

ONE SMALL STOCKPILE (0.5 AF) WAS CONSTRUCTED AND IS LOCATED ON FIGURE 1.

(g) Description of any environmental problem areas with a proposed plan for mitigation and illustration on a map, including, but not limited to:

1. Pit stability problems.

NONE

2. Subsidence.

NONE

3. Accidental water discharge, dam failure, etc.

NONE

4. Slumping, sliding or erosion.

NONE

5. Revegetation problem areas.

NONE

6. Existence and location of unsuitable (toxic) overburden.

NONE

RECLAMATION:

(a) Tabulation of the acreage reclaimed during the report period with illustration on a map, distinguishing between:

1. Backfilled, graded and contoured areas.

Area	Acreage
NONE	

2. Topsoiled areas.

Area	Acreage
NONE	

3. Seeded areas.

Area	Acreage
NONE	

4. Reseeded areas (areas previously seeded, then seeded again).

Area	Acreage
NONE	

(b) Tabulation of total acreage reclaimed (seeded with permanent seed mix) to date by years with illustration on an updated map:

Year	Acreage
1975	0
1976	0
1977	0
1978	0
1979	0
1980	0
1981	0
1982	0
1983	0
1984	0

(c) Description of the reclamation procedures used during the report period, including:

1. Average depth of topsoil applied.
NONE

2. Type of seed (species) used for seeding during the report period.
NONE

3. Date of seeding during the report period.

Spring NONE

Fall NONE

4. Seeding procedures used.

(Hand broadcast or drilled or any other).
N/A

5. Rate of seed application.

Pounds Per Acre of Pure Live Seed (PLS) (if varied, please explain)
N/A

6. Type and rate of fertilizer applied.
N/A

7. Type and rate of mulch applied.
N/A

8. Rate of irrigation water applied, if any. Please describe any type of sprinkling, or water applied (water truck, etc.).
N/A

9. Revegetation test plot information.

(Cover, density, productivity, etc.)
A SUMMARY OF THE USFS REVEGETATION PROGRAM IS PRESENTED IN APPENDIX A.

10. Soil analysis results.
NONE

(d) Description of results of previous revegetation efforts, including: (This should be done as applicable.)(This does not include the USFS Studies)

1. Types (species) of seed that have germinated and are growing.
INTERMEDIATE WHEATGRASS (AGROPYRON INTERMEDIUM)
PUBESCENT WHEATGRASS (AGROPYRON TRICHOPHORUM)
FOUR-WING SALTBUSH (ATRIPLEX CANESCENS)
PLAMER PENSTEMON (PENSTEMON PALMAIR)

2. Types (species) of seed that are not growing successfully.
GREEN NEEDLEGRASS (STIPA VIRIDULA)
WINTERFAT (CERATOIDES LANATA)
BLUE GRAMMA GRASS (BOUTELOUA GRACILIS)

3. Areas experiencing problems with weeds and weed types.
NO SIGNIFICANT PROBLEMS

4. Significant erosional problems.
NONE

5. Areas of unsuitable overburden on the surface as related to revegetation failure.
NONE

6. Procedures used or proposed to correct these problems.
NOT APPLICABLE

7. Acreage and dates of release (upon inspection by the State) of revegetated areas.

Area	Date	Acreage
N/A		

8. Results of soil analysis.

N/A

(e) Summarization of the reclamation costs incurred during the report period, including itemized costs for each operation (i.e., grading, topsoil replacement, seeding, etc.) and for each type of disturbance (i.e., spoil, haul roads, facilities removal, etc.) on a per acre basis.

	Acres	Cost/Acre
1. Grading	N/A	N/A
2. Backfilling	N/A	N/A
3. Contouring	N/A	N/A
4. Topsoil Replacement	N/A	N/A
5. Seeding	N/A	N/A
A. Seedbed Preparation	N/A	N/A
B. Mulch	N/A	N/A
C. Fertilizer	N/A	N/A
D. Seed	N/A	N/A
6. Other	N/A	N/A

BOND INFORMATION:

A. An updated bond estimate should be included, if required in the Division's approval of the Mining and Reclamation Plan (MRP) or if changes to the MRP have occurred, including a detailed itemization of actual/estimated reclamation costs as outlined in the RECLAMATION section above. The date of the release of revegetated areas from further responsibility for a partial bond release, if applicable, should also be included.

	Amount	Type	Date Posted
Present Bond	150,000	CD	July 16, 1984

Increased disturbance, if any:

NONE

Increased Bond Amount (attached reclamation estimate).

B. Bond release.

Acres	Bond Amount Released	Date
	N/A	

ADDITIONAL INFORMATION:

Supply any additional information as requested by the Division related to:

(a) Permit stipulations (status).
(b) Other special conditions (status).

APPENDIX A

STATUS OF THE U.S. FOREST SERVICE REVEGETATION TEST PLOT STUDY

During 1983 a revegetation test plot study was initiated by Geokinetics and the U.S. Forest Service - Logan Experimental Station. A spent retort (#24) selected for the test was seeded in the spring and fall of 1983 (Figure 1). A copy of the study plan, and both spring and fall establishment reports are included in this appendix.

Data were gathered on the test plot during August of 1983, and June and August of 1984. Both, percent frequency of occurrence and percent aerial cover were taken. The data being preliminary, will not be presented at this time. However, general observations made in June and August of 1984 are discussed below.

In August 1985, data will again be taken on the study plot for both the spring and fall seedings. An interim report by the USFS will be presented to the Seep Ridge Shale Oil Company following this sampling. This report should include an analysis of the data along with conclusions and recommendations for revegetation practices.

It is anticipated that data collection will be continued on the plots, at least during the initial years of the project.

This data base will be a significant contribution in the decision of the appropriate seeding mixture and practices during revegetation.

SPRING SEEDING

June 1984

During June 1984, Mr. Robert Ferguson of the U.S. Forest Service examined the spring-seeded plot and evaluated the differences between the irrigated and non-irrigated portions of the plot. The following comments are based upon the frequency data taken in June and Mr. Ferguson's general observations:

(1) Seeded grasses are not quite as dense on the non-irrigated area as on the irrigated area.

(2) The most dominant seeded grass species, tall wheatgrass, is not quite as dense on the non-irrigated area as on the irrigated area.

(3) Alkali sacaton, western wheatgrass, and the bluebunch wheatgrass-quackgrass hybrid all occur more frequently on the irrigated area than on the non-irrigated area.

(4) Russian wildrye occurs more frequently on 3 of the 5 non-irrigated treatments than on the same 3 irrigated treatments.

(5) Although surviving forb species are scarse on both irrigated and non-irrigated areas, they are more frequent on the non-irrigated area.

(6) Fourwing saltbush is considerably more frequent in occurrence on the non-irrigated area. On the shrub-seeded treatments it may occur more frequently than all other species except tall wheatgrass and Russian wildrye.

(7) The almost total absense of forbs and the rarity of surveying shrubs on the irrigated area, where grass competition has been severe, is indicative of the difficulty of establishing forbs and shrubs simultaneously with a dense stand of grass.

(8) Winterfat that were present in September 1983 appear almost non-existent now.

(9) Where grass density is greatest on the "irrigated" area, the grasses are obviously suffering from moisture stress this year. The slightly more"open" grass stand on the non-irrigated area currently supports more vigorous individual grass plants.

(10) On the densest portions of the irrigated area, two grass species that appear more tolerant of moisture stress are Russian wildrye and Alkali sacaton.

(11) Echinochloa crus-galli and Avena sativa virtually disappeared from the spring-seeded area, apparently being unable to reproduce the second year.

August 1984

A survey of the spring plot was conducted by the USFS in August 6, 1984. Their observations indicate, at this stage of the growing season, that probably 95% of the seeded area has an excellent stand of grass. Few forbs were noticeable, and the scattered plants of four-wing saltbush are rather inconspicuous and occur primarily on the non-irrigated half of the area. To

the "eye", there was practically no difference in appearance of the irrigated and non-irrigated halves.

Sporabolus airoides plants were vigorous, especially on the irrigated half. No Bouteloua gracilis seed heads were noticeable, which tends to verify the scarcity of this species in the June data. In contrast, Bouteloua was in seed in the native stands of the area.

Irrigation during the first growing season resulted in a better stand of Sporabulus. The "lower" end (Block 5) has a denser stand, and was somewhat greener in color than the remainder of the spring-seeded area. The difference in density of Sporabulus was especially apparent on the irrigated and non-irrigated portions of Block 5.

FALL SEEDING

June 1984

On June 28, 1984 the USFS examined the experimental seeding that was conducted in the fall of 1983 on the south half of Retort #24. Their observations indicate that considerable variability exist, at this time, in the density of vegetation on the fall-seeded portion of the study area. The amount of vegetation ranges from essentially zero on some areas to a high density of the seeded species on other areas.

The density of seeded grass species appears greatest on straw-mulched areas, with grass density slightly higher on fiber-mulched areas than on non-mulched areas. Type of mulching has less influence on forb and shrub establishment than has irrigation. All species of forbs and shrubs are more abundant on the irrigated area than on the non-irrigated area.

There were no winterfat or rabbitbrush seedlings found during the survey of the plots. However, a relatively high number of Palmer pentstemon was scattered on both the irrigated and non-irrigated areas.

In addition, shadscale was more common on the non-irrigated area than on the irrigated area.

During the June survey there was not nearly as much Echinochloa crus-galli or Avena sativa on the area as was evident on the 1983 spring-seeded portion of the retort. These 2 species, which were a contaminant of the straw mulch, may become more evident later in the growing season. On the other hand, several "weed" species occur on the fall-seeded portion of the retort that were not in evidence in 1983 on the spring-seeded area.

These include: Bromus tectorum; Descurainia sophia; Lappula redowski; Malcomia africana; Schoencrambe linifolia; and Brassica nigra, in approximate order of abundance. Only the Bromus and Descurainia occur in sufficient numbers to provide significant competition for soil moisture. All of these "weed" species were much more abundant and vigorous on the irrigated area.

August 1984

Again, general observations were conducted by the USFS on the fall-seeded plot. Their observations indicate that the irrigated portion has more vegetative mass, but this is due to the vigorous growth of "weed" species such as: Kochia scoparia; Chenopodium album; Descurainia sophia; Salsola kali; and Echinchloa crus-gali, on the straw mulched plots.

The established seeded grasses are somewhat more vigorous on the irrigated portion than on the non-irrigated portion. However, excellent summer rainfall has aided the established vegetation on both portions.

Use of straw mulch resulted in the establishment of more Kichia scoparia on the non-irrigated plots and more Echinochloa crus-gali on irrigated plots. A few other "weed" species, such as Rumex sp. and Chenopodium glaucum were evident during August in addition to those listed in June.

EFFECT OF SEASON OF SEEDING AND MULCHING TREATMENT ON REVEGETATION SUCCESS ON IN SITU OIL SHALE RETORTS

STUDY PLAN

By

ROBERT B. FERGUSON

Intermountain Forest and Range Experiment Station

Research Work Unit 1603

Logan, Utah

In Cooperation With:

Geokinetics, Incorporated

Salt Lake City, Utah

Geokinetics, Incorporated of Salt Lake City, Utah is presently extracting oil from oil shale located in the southern portion of Utah's Uinta Basin by an in situ retorting process. The method used involves fragmenting the oil shale by setting off precisely placed explosive charges. Following fragmentation, holes are drilled into the shale layer and the shale is ignited. Air is forced into the holes to supply oxygen to sustain combustion. As the combustion front progresses horizontally, the kerogen in the shale is pyrolized and condensed. The synthetic crude then drains to the retort bottom and is recovered through pump wells.

The first of these in situ retorts were small (400 sq. ft. to less than 1/3-acre). However, recently developed retorts have approached two acres in size. The oil shale rock has been covered by only 2 to 60 feet of overburden. As a result of the fragmentation of the shale by explosives, the overlying material is lifted up to form a mound over the fractured zone of shale. Such mounds may be as much as 8 feet (usually less) higher than the original land surface.

The land surface immediately above the retort is usually denuded of vegetation in the process of drilling and pumping. It is often necessary to remove pinyon or juniper trees to facilitate the procedure. The area adjacent to the retorts is also disturbed by the movement of equipment and vehicles.

Efforts have been made since about 1979 to develop successful methods of re-establishing a vegetative cover on retort areas from which the extraction of shale oil has been completed. These efforts have met with limited success, especially on the "raised" portion of the retorts where soil material is often shallow. Some areas around the edges of the raised retorts have supported good stands of grass. Thus the primary obstacle to successful establishment of adequate vegetation appears to be a lack of soil depth. Associated with

the factor of soil depth is the necessity to prepare the soil surface in a manner that will retain precipitation or applied supplemental water on the area and hold surface runoff to a minimum.

There is a need to include adapted legume and shrub species in revegetation planning. Several adaptability trials made on smaller retort areas of the Geokinetics site have revealed a number of shrubby and herbaceous species that can be used in reclamation. However, most of the species tested to date have been plants that are not native to this part of Utah, or were native species the seed of which was collected in other parts of Utah or the Intermountain West. Local sources of native shrub species should be tested to determine their competitive capacity when used in a seed mixture.

This study is designed to yield information on alternative cultural methods and suitable herbaceous and shrubby species for establishing a level of vegetative cover adequate to meet government reclamation requirements. Specific objectives are: (1) to determine the relative success of direct seeding in conjunction with three mulching treatments (straw, wood fiber, or no mulch), (2) to evaluate the vegetative stand obtained when only herbaceous species are used or when both herbaceous and shrubby species are used. (3) to obtain preliminary information on the value of supplemental water, applied by irrigation during the growing season, on successful vegetation establishment, (4) to assess the effect of season of direct seeding (spring vs. autumn) on vegetation establishment, and (5) to determine the success of establishment of several native shrub species when direct seeded in association with perennial grasses.

STUDY AREA

Location of the study area is on lands owned by the State of Utah, and leased by Geokinetics, Incorporated, in Section 2, Township 14 South, Range 22 East, Uintah County.

Elevation at the site is approximately 6,700 feet (2 042 m). Average Annual precipitation is about 13 inches. Native vegetation of the area is dominated by the pinyon-juniper type, with locally interspersed areas of sagebrush-grass and sagebrush-saltbush types. Soils are well drained, and derived primarily from ~~shale and sandstone~~ marlstone parent material.

METHODS

A 1.25- acre retort (Geokinetics No. 24) was selected by Geokinetics for use in this study.

Shale oil extraction from the retort began in December, 1980 and was completed in July, 1981. The top of the burned oil shale layer was approximately 45 feet below the original ground surface. Retorting was begun under the southeast end of the retort and proceeded toward the northwest end.

Upon completion of shale oil extraction, the retort surface was covered with approximately four inches of the topsoil material that was originally removed in preparation for "burning" the retort, and then reshaped to minimize the slopes around the retort perimeter (Appendix Figure 1).

Soil samples were taken from the top 12 inches of the soil material in November, 1982, and exhibited the following characteristics:

Soil reaction (pH): 8.0-8.4 ($\bar{x}$ = 8.1)

electrical conductivity (ECe): 2.6-6.8 ($\bar{x}$ = 4.6)

phosphorous (ppm): 1.6-7.8 ($\bar{x}$ = 3.7)

potassium (ppm): 284-400 ($\bar{x}$ = 348)

sodium (meq /l); 8.3-42.2 ($\bar{x}$ = 24.6)

estimated SAR: 2.8-14 ($\bar{x}$ = 7.4)

Treatments

The following five treatments will be applied on the retort area; half of the area will be treated in early April 1983, and the remaining half will be treated in October or November, 1983. (The plot design is shown in Appendix Figure 1):

(A) seeded with a grass-forb mixture, and muched with straw

(B) seeded with a grass-forb mixture, and mulched with wood fiber

(C) seeded with a grass-forb-shrub mixture and mulched with straw

(D) seeded with a grass-forb-shrub mixture, and mulched with wood fiber.

(E) seeded with a grass-forb-shrub mixture, but not mulched

The seed mixture will be as follows, contingent on availability of seed:

For treatments A and B:	lbs./acre PLS
Bouteloua gracilis; "Lovington"	1
Sporobolus airoides	0.5
Oryzopsis hymenoides; "Nezpar"	3
Agropyron elongatum; "Alkar"	6
Agropyron inerme; "Whitmar"	4
Agropyron smithii; "Rosanna"	4
Ag. spicatum X Ag. repens; ARS hybrid	3
Elymus junceus	4
Hedysarum boreale	2
	27.5

For treatments C, D, and E:	lbs./acre PLS
Bouteloua gracilis; "Lovington"	1
Sporobolus airoides	0.5
Oryzopsis hymenoides; "Nezpar"	2
Agropyron elongatum; "Alkar"	3
Agropyron inerme; "Whitmar"	2
Agropyron smithii; "Rosanna"	2
Ag. spicatum X Ag. repens; ARS hybrid	1.5
Elymus junceus	2
Atriplex canescens	5.7
Atriplex confertifolia	4.9
Artemisia tridentata	0.4
Ceratoides lanata	3.2
Chrysothamnus nauseosus	0.13
Hedysarum boreale	2
	30.33

Site Preparation, Seeding, and Mulching

Prior to seeding, inorganic fertilizer will be broadcast on the entire study area at the rate of 60 lbs/acre of nitrogen and 51 lbs/acre of phosphorus. Fertilizer will be incorporated into the top 12 to 14 inches of soil by ripping and harrowing. In addition, gypsum will be applied, with the fertilizer, at a rate of 1 ton per acre.

Seed will be sown with a Brillion seeder-cultipacker, drawn by a small caterpillar tractor. Sufficient seed will be placed in the seed hopper to permit the seeding of treatments A and B first (no shrub seed included). Once treatments A and B are completed, the seed hopper will be loaded with

sufficient grass and forb seed to seed treatments C, D, and E. However, shrub seed will be mixed together and divided into small packets, with one packet of seed added to the seed hopper as each 5-ft by 175-ft strip is sown.

Mulching material will be applied immediately after seeding. Straw will be spread at 2,400 lbs/acre and tacked down with a straw crimper. Wood fiber will be blown on at a rate of one ton per acre.

Provision for Supplemental Water

One-half of both the spring and autumn seeded areas will be sprinkler irrigated. Irrigation will begin no later than April 15, and will be applied at a rate of 1 inch of water on the initial date of irrigation and 0.5-inches of water at weekly intervals thereafter, through September 2. This is equivelent to 11 inches of water (298,700 gallons/acre) for the 21-week period.

Soil water potential will be monitored twice monthly, beginning 6 days after the date of initial irrigation, through the use of thermocouple psychrometers. Preferrably, readings will be made on the day prior to each irrigation, or immediately before turning on the irrigation system. Psychrometers will be placed in the soil at four locations on the irrigated half of the seeded area and at four locations on the non-irrigated area. At two of the four locations, psychrometers will be placed at depths of 4, 8, and 12 inches, while at the other two locations an additional psychrometer will be placed at a depth of 24 inches. Soil temperature can be monitored with the same thermocouple psychrometers.

Experimental Design

The study will be set up as a stratified randomized, split plot design, with five blocks. Each treatment will be represented in each block by a 10-ft-wide by 100-ft-long strip (Appendix Figure 2).

Data will be taken on percent frequency in August of each growing season, using a nested plot plot method, as described in section 4.63 of FSH 2209.21 R-4 (Range Analysis Handbook). In each 10-ft by 50-ft strip (representing a single treatment in each "block"), a 10-sq-ft sampling frame will be placed down five times. The locations will be chosen by drawing random numbers from 0 to 49, which in turn represent 1-foot segments along a tape stretched along one side of the strip to be sampled. If the number is even, the frame will be placed down on the left half of the 10-ft-wide strip; if the number is odd, the frame will be placed down on the right half of the strip. The 10-sq-ft frame is divided into 10-sq ft subplots, one of which is further divided into 9-sq-dm subplots. Each time the frame is placed down, the presence of each specific class or species being sampled will be recorded in four sizes of plot, i.e. 10 sq ft, 5 sq ft, 1 sq ft, and 1 sq dm. Percent aerial cover of vegetation will also be sampled by estimating the percent cover in the four 1-sq-ft corner segments of the frames each time it is laid down.

In August 1983 "grasses" will not be sampled by individual species because of the tediousness of distinguishing species of very young plants. Similarly, in August 1984 grasses from the seeding made in the autumn of 1983 will be tallied as a class. Forbs and shrubs will be recorded by individual species on each sampling date. Grass species should be recognizable by the second growing season.

Beginning with the 1985 sampling, data will be taken on yield, by species, utilizing the same randomly located 10-sq-ft plots from which frequency data are obtained. It may be desirable to sample in July instead of August, beginning in 1985. The weight-estimate method will be used for sampling yields.

Data on percent frequency and yield will be subjected to analysis of variance, as outlined below.

	d.f.
Blocks (5)	4
Treatments (5)	4
Error	16
	24

If analyses of variance tests indicate significant differences between treatments, data will be examined and a decision made on appropriate transformation and multiple comparison methods.

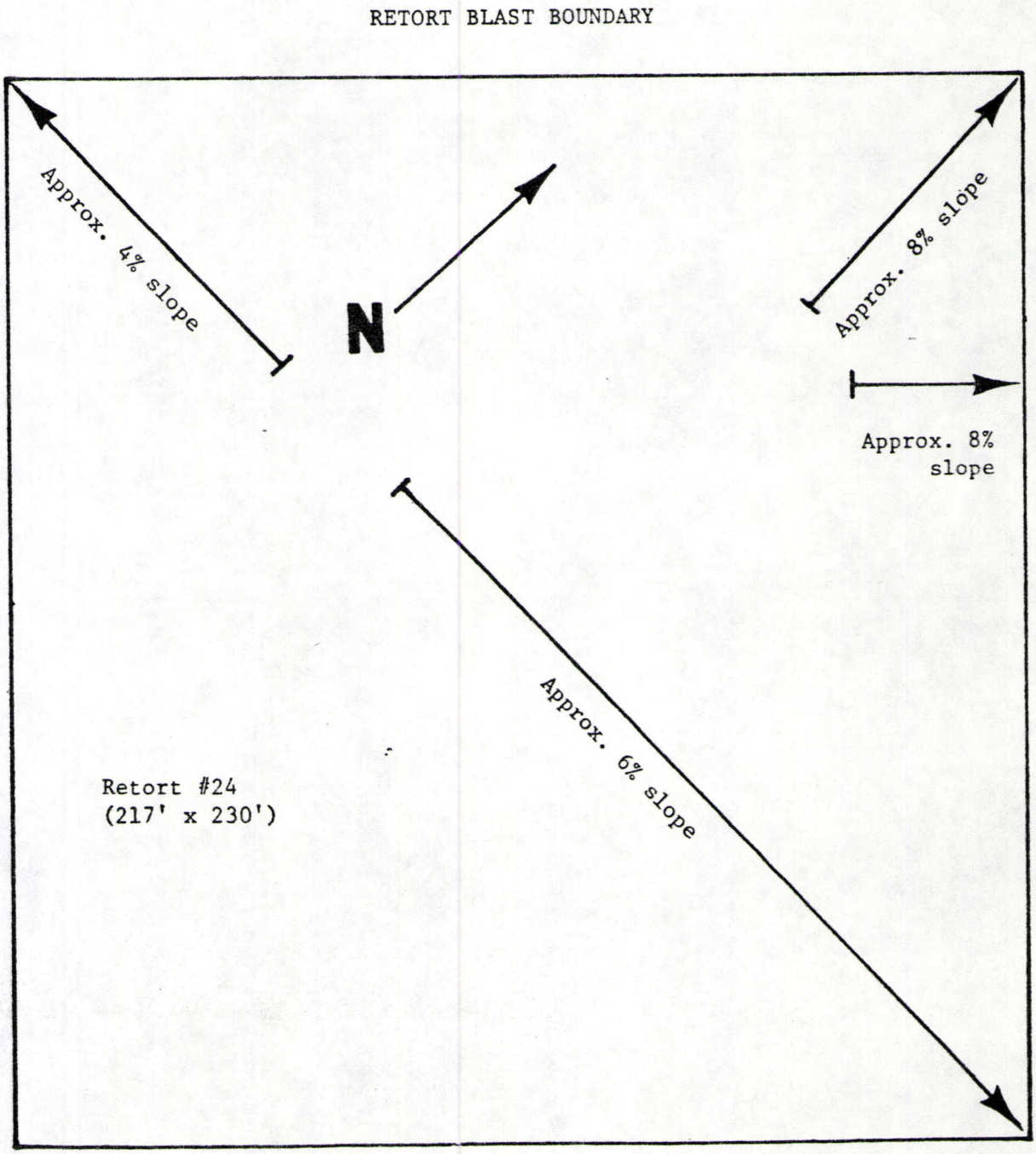
Study Establishment and Data Collection

Personnel of the Intermountain Forest and Range Experiment Station will prepare the retort surface and make the seedings, both in the spring and autumn of 1983. Station personnel will also install the irrigation system, with the assistance of Geokinetics personnel, sud will install thermocouple psychrometers as outlined in the study plan.

Data on vegetation parameters will be obtained by Intermountain Station personnel. Data on soil water potential will normally be collected by Geokinetics personnel, as it would be too expensive for Station personnel to travel to the study site from Logan or Provo on a weekly or bi-weekly basis.

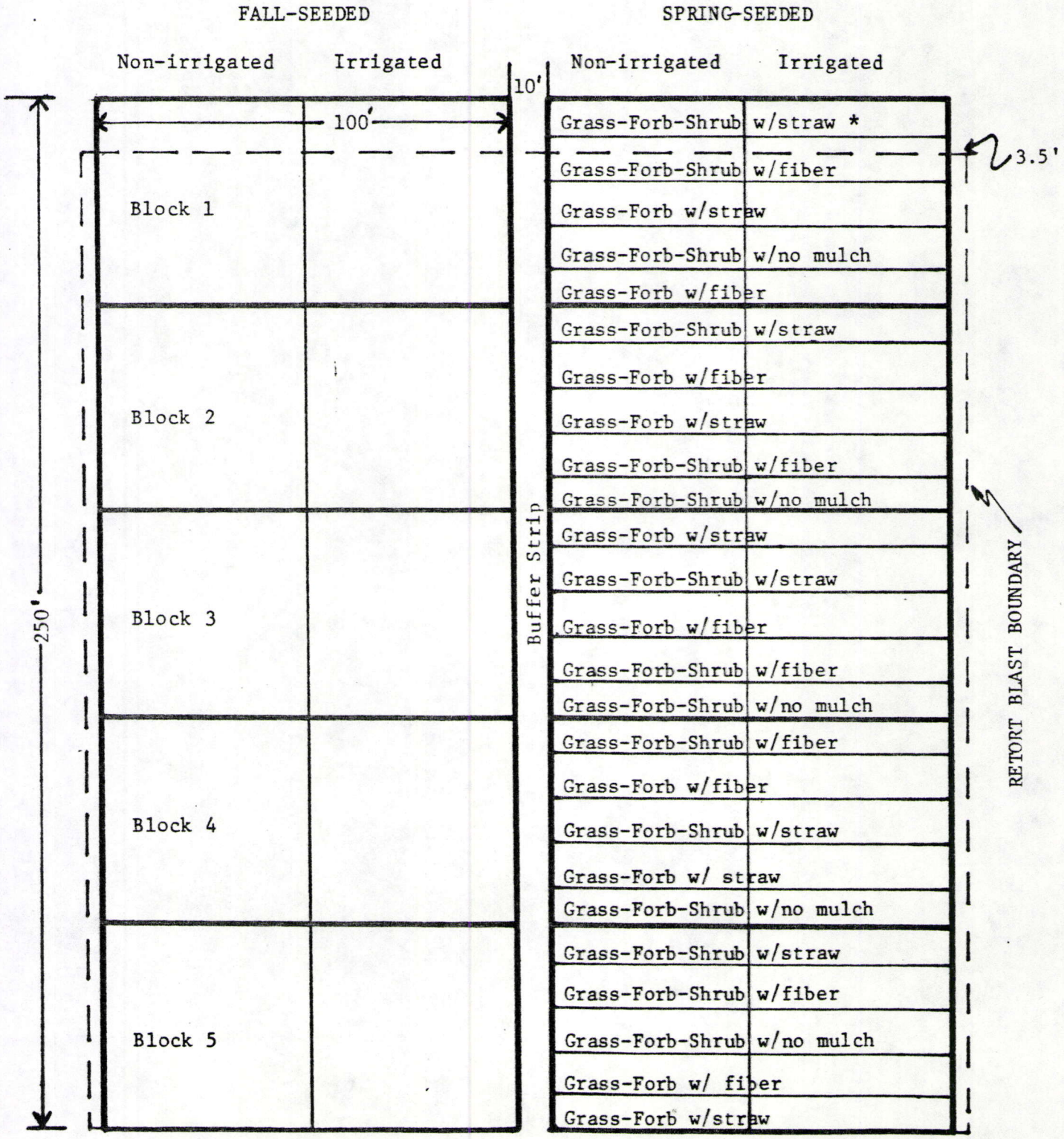
Geokinetics, Inc. will apply supplemental water as scheduled, or deemed to be needed, depending on natural precipitation received.

Appendix Figure 1. Approximate configuration of Geokinetics Retort No. 24 following surface shaping.



Scale: 1 in. = 35 ft.

Appendix Figure 2. Field plot design for Retort No. 24, showing season of seeding, treatment sequence within each block, and irrigated vs. non-irrigated portions.



* Order of treatments is the same in both spring and fall seedings.

EFFECT OF SEASON OF SEEDING AND MULCHING TREATMENT

ON REVEGETATION SUCCESS ON IN SITU OIL SHALE RETORTS

ESTABLISHMENT REPORT

The spring seeding phase of the study was done May 23 and 24, 1983. Cold, wet weather prevented working the soil until May 1, and the work schedule of Intermountain Station personnel prevented our doing the seeding during the first week of May. An effort was made to accomplish the job the week of May 9; but, once again, snow storms made the soil too wet.

The application of gypsum and inorganic fertilizer was made as described in the study plan. Both materials were spread on the test area (prior to ripping and harrowing) through the use of a two-wheeled fertilizer spreader pulled by a small, wheeled tractor.

The shrub seed was broadcast by hand, to ensure an even distribution. The grass and forb seed was mixed together and sown with the Brillion seeder-packer, after the shrub seed had been sown. Thus, the Brillion also served to press the shrub seed into the soil. In addition to the species shown in the study plan, the following forbs were added to the mixture for all treatments: Sphaeralcea munroana, Sphaeralcea grossulariaefolia, and Penstemon palmeri.

At the completion of seeding on treatments A and B there was 1.2 pounds of the grass-forb seed mixture remaining in the seed hopper. Thus, the actual seeding rate for these treatments was:

	lbs/acre, PLS
Blue grama	1.1
Alkali sacaton	0.6
Indian ricegrass	3.3
Tall wheatgrass	6.7
Beardless wheatgrass	4.4
Western wheatgrass	4.4
Bluebunch wheatgrass-Quackgrass hybrid	3.3
Russian wildrye	4.4
Utah sweetvetch	1.4
Munro globemallow	0.06
Gooseberry-leaf globemallow	0.29
Palmer penstemon	0.24
TOTAL	30.09

Mulching material (straw or wood fiber) was applied to the seeded area as prescribed. Some difficulty was encountered in limiting the blown straw to only the treatments for which it was intended. However, part of the straw that fell on areas of the other treatments was raked off, and it is expected that the relatively small amount remaining will have little effect on those areas.

At the completion of seeding of treatments C, D, and E there was 2.17 pounds of the grass-forb seed mixture remaining in the seed hopper of the Brillion seeder. Thus, the actual seeding rate for treatments C, D, and E was:

	lbs/acre, PLS
Blue grama	.58
Alkali sacaton	.29
Indian ricegrass	1.16
Tall wheatgrass	1.74
Beardless wheatgrass	1.16
Western wheatgrass	1.16
Bluebunch wheatgrass-Quackgrass hybrid	1.74
Russian wildrye	1.16
Utah sweetvetch	.74
Munro globemallow	.03
Gooseberry-leaf globemallow	.15
Palmer penstemon	.12
Fourwing saltbush	5.70
Shadscale	4.90
Big sagebrush	.40
Winterfat	3.20
Rubber rabbitbrush	.13
TOTAL	24.36

Thermocouple psychrometers were buried at two locations on the portion of the site that will be irrigated, and on two locations on the portion that will not be irrigated. Psychrometer numbers and their locations are shown below:

PSYCHROMETERS LOCATED AT GEOKINETICS STUDY SITE ON MAY 25, 1983

Treatment E (irrigated), Block No. 2:

Psychrometer No.	Depth (in.)
12	4
1	8
11	12

Treatment C (irrigated), Block No. 4:

Psychrometer No.	Depth (in.)
16	4
8	8
14	12
20	24

Treatment C (non-irrigated), Block No. 4:

Psychrometer No,	Depth (in.)
22	4
24	8
27	12

Treatment E (non-irrigated), Block No. 2:

Psychrometer No.	Depth (in.)
7	4
19	8
4	12
10	24

The sprinkler irrigation system was installed by Geokinetics personnel May 25 and 26 with irrigation scheduled to begin immediately.

EFFECT OF SEASON OF SEEDING AND MULCHING TREATMENT ON REVEGETATION SUCCESS ON IN SITU OIL SHALE RETORTS

ESTABLISHMENT REPORT

The autumn seeding phase of the study was done October 25 and 26, 1983. Weather during the two days of work was cool and sunny, with virtually no wind.

Gypsum and inorganic fertilizer was applied in the same manner as for the spring seeding. The study area was then "ripped" across the short dimension of the site with a road grader, followed by ripping across the long dimension of the site with the small caterpillar. The site was next harrowed with a springtooth harrow prior to seeding.

As in the spring, the shrub seed was broadcast by hand, to ensure an even distribution, prior to sowing of the grass and forb seed with the Brillion seeder-packer.

The seeding rate was intended to be the same as that used in the spring seeding. This was accomplished reasonably well on the grass-forb seeded areas, with 1,025 grams remaining the seed hopper after all 10 strips had been seeded. However, when only 30 percent of the seeding operation on the grass-forb-shrub strips had been completed it was realized that seed was being dispensed from the Brillion seeder in greater than the desired quantity. The setting on the hopper of the Brillion was then changed from the "wide open" position to a setting of "3" for the seeding of the remaining 70 percent of the area. Thus, as closely as can be determined, the seeding rate for the autumn seeding was as follows:

For treatments A and B--

	lbs/acre, PLS
Blue grama	1.0
Alkali sacaton	.5
Indian ricegrass	2.9
Tall wheatgrass	5.9
Beardless wheatgrass	3.9
Western wheatgrass	3.9
Bluebunch wheatgrass-Quackgrass hybrid	3.0
Russian wildrye	3.9
Utah sweetvetch	1.3
Munro globemallow	.06
Gooseberry-leaf globemallow	.26
Palmer penstemon	.21
TOTAL	26.8

For treatments C, D, and E--

	lbs/acre, PLS	
Blue grama	0.9	(1.9)[1]
Alkali sacaton	0.5	(1.0)
Indian ricegrass	1.9	(3.9)
Tall wheatgrass	2.9	(5.8)
Beardless wheatgrass	1.9	(3.9)
Western wheatgrass	1.9	(3.9)
Bluebunch wheatgrass-Quackgrass hybrid	2.9	(5.8)
Russian wildrye	1.9	(3.9)
Utah sweetvetch	0.7	(1.1)
Munro globemallow	.06	(0.1)
Gooseberry-leaf globemallow	.25	(0.5)
Palmer penstemon	.20	(0.4)
Fourwing saltbush	5.7	
Shadscale	4.9	
Big sagebrush	.4	
Winterfat	3.2	
Rubber rabbitbrush	.13	
TOTAL	30.34	(46.5)

[1]Amount in parentheses is the estimated seeding rate for treatments C, D, and E in Block 5, and treatment E and the south 1/2 of treatment C in Block No. 4 of the autumn-seeded area.

For the record, we had started seeding of the grass-forb-shrub treatments in Block No.5, and had progressed through the south one-half of treatment C

in Block No. 4 when we realized that seed was being spread in too great a quantity. Thus, it should be recognized, in future evaluations of the established vegetation, that these portions of the autumn-seeded area were seeded quite heavily!

Thermocouple psychrometers were installed at two locations on the portion of the autumn-seeded area that will be irrigated, and at two locations on the portion that will not be irrigated. Psychrometer numbers and their locations are shown below:

PSYCHROMETERS LOCATED AT GEOKINETICS

STUDY SITE ON OCTOBER 26, 1983

Treatment B (irrigated), Block No. 2

Psychrometer number	Depth (in.)
26	4
28	8
21	12

Treatment C (irrigated), Block No. 4

Psychrometer number	Depth (in.)
2	4
5	8
18	12
13	24

Treatment B (non-irrigated), Block No. 2

Psychrometer number	Depth (in.)
6	4
9	8
25	12
3	24

Treatment C (non-irrigated), Block No. 4

Psychrometer number	Depth (in.)
15	4
23	8
162	12